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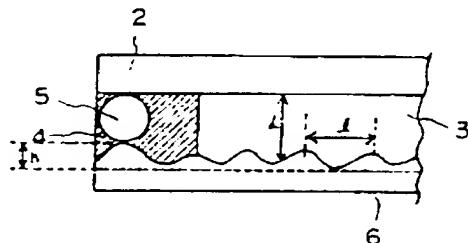
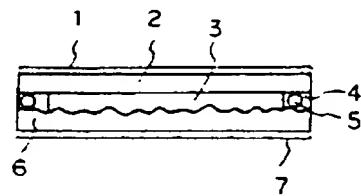
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APPLICANT : SEIKO EPSON CORP;

INVENTOR : KUROIWA MASAHIRO;

INT.CL. : G02F 1/1333

TITLE : LIQUID CRYSTAL SHUTTER



ABSTRACT : PURPOSE: To obtain a uniform contrast in a wide visual angle range by forming the surface of an electrode substrate on the side in contact with a liquid crystal layer to a rugged shape.

CONSTITUTION: The surface of the lower electrode substrate 6 of the upper electrode substrate 2 and the lower electrode substrate 6 of a liquid crystal cell on the side in contact with the liquid crystal layer 3 is provided with ruggedness by etching using hydrofluoric acid, etc., and an ITO film is formed thereon. The film is subjected to an orientation treatment. The height h is 0 to 5 μ m and the spacings l of the ruggedness array irregularly at 10 to 500 μ m. The product $\Delta n \cdot d$ of the refractive index anisotropy Δn and cell thickness d of the liquid crystal, therefore, varies at the fine pitch of l=10 to 500 μ m and, therefore, the colors by the respective $\Delta n \cdot d$ are subtracted and the coloring of the panel is substantially invisible. The liquid crystal shutter having the uniform contrast within the wide visual angle range is eventually obtd.

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LIQUID CRYSTAL SHUTTER

Patent Number: JP2211422

Publication date: 1990-08-22

Inventor(s): KUROIWA MASAHIRO

Applicant(s): SEIKO EPSON CORP

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Abstract

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CONSTITUTION: The surface of the lower electrode substrate 6 of the upper electrode substrate 2 and the lower electrode substrate 6 of a liquid crystal cell on the side in contact with the liquid crystal layer 3 is provided with ruggedness by etching using hydrofluoric acid, etc., and an ITO film is formed thereon. The film is subjected to an orientation treatment. The height h is 0 to 5μm and the spacings l of the ruggedness array irregularly at 10 to 500μm. The product DELTA_{n,d} of the refractive index anisotropy DELTA_n and cell thickness d of the liquid crystal, therefore, varies at the fine pitch of l=10 to 500μm and, therefore, the colors by the respective DELTA_{n,d} are subtracted and the coloring of the panel is substantially invisible. The liquid crystal shutter having the uniform contrast within the wide visual angle range is eventually obtd.

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⑮発明の名称 液晶シャッター

⑯特 願 平1-33119

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明細書

共に平坦であった。

〔発明が解決しようとする課題〕

前記従来技術の様に、電極面が平坦な電極基板を用いると、均一なコントラストを必要とする液晶シャッターでは、特に電圧印加時の視角が狭いという問題点を有していた。

そこで本発明はこのような問題点を解決するもので、その目的とするところは、広い視角範囲で、均一なコントラストをもった液晶シャッターを提供する事にある。

〔課題を解決するための手段〕

本発明の液晶シャッターは、対向する内面に電極が形成された一対の電極基板間に配向された液晶層を挟持してなる液晶セルと、前記液晶セルの少なくとも一方の外側に偏光板を有してなる液晶シャッターにおいて、少なくとも一方の前記電極基板の前記液晶層と接する側の面が、凹凸形状を有する事を特徴とする液晶シャッター。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明は液晶シャッターの構造に関する。

〔従来の技術〕

従来の液晶シャッターは、液晶層を挟持する2枚の電極基板の前記液晶層と接する側の面は両側

〔実施例〕

第1図に本発明の液晶シャッターの断面図を示

す。同図において1は上偏光板、2は平坦な電極面を有する上電極基板で配向処理を施してある。3は90°のねじれ配向したネマチック液晶層で、前記上電極基板2と対向する下電極基板6とシール材4を介して挟持されている。下電極基板6の液晶層3に接する側の面は、ガラス表面をフッ酸等によりエッチングを施し、そのうえにITOを形成、さらに配向処理を施してある。5は前記上電極基板2と前記下電極基板6を一定の間隔に保つためのスペーサーでシール材4の中に差合されている。7は下偏光板である。以上本実施例の液晶シャッターの構造について簡単に述べたが、次に第2図に従って第1図の詳細について述べる。第2図において下電極基板6はフッ酸等によりエッチングを施し凹凸を備けてある。その上にスパッタ等によりITOを形成してある。ITO形成後の凹凸の大きさは、高さ方向hが0~5μm、また凹凸の山と谷または谷と谷の間隔lは10μm~500μmで、不規則にならんでいる。

以上の様な構造を持つ下電極基板6と平坦な電

極表面をもつ上電極基板2を第1図如きの液晶セルにし、例えばスペーサー5を5μmとすれば液晶セルのセル厚dは5μm~10μmの間の全ての厚さを同一セル内に不規則に有する事になる。

一方、液晶セルの視角依存性は、視角によって液晶の屈折率異方性Δnとセル厚dとの積、 $\Delta n \times d$ が変化するたに、すなわち色変化が起こるため起こる。ここで第2図における液晶層3の Δn の大きさを、たとえば0.08とすれば、 $\Delta n \times d$ は0.4~0.8μmに、また Δn を0.16とすれば、 $\Delta n \times d$ は0.8~1.6の範囲で、同一セル内に不規則に有する事になる。

よってl=10~500μmと細密なピッチで $\Delta n \cdot d$ の値が変化するため、各 $\Delta n \cdot d$ による色は減色されてパネルの色づきは殆ど見えなくなる。また液晶セルを斜め方向から見た場合においても、前記と同様に、細密なピッチで $\Delta n \cdot d$ が変化するため、色度化が起こらず、結果として広い視角範囲内で均一なコントラストを有する液晶シャッターを作ることができる。

第4図は本発明第1の実施例の構造を持つ液晶シャッターと通常のTN型液晶シャッターの、0N時の視角方向と透過率の関係を表わす図である。

尚セルの詳細な条件は下記の通りである。第4図より、本発明の液晶表示装置は従来のTN型液晶シャッターに比べて広い視野範囲内で均一なコントラストを得られる事がわかる。

本発明の液晶シャッター (A)

- ・ポジ型（電圧無印加時の透過率の方が、印加時の透過率より高い表示）

- ・ $\Delta n \cdot d$ の範囲 0.8~1.6μ

- ・ツイスト角 90°

TN型液晶シャッター (B)

- ・ポジ型

- ・ $\Delta n \times d = 1.1\mu$

- ・ツイスト角 90°

測定条件

セルの垂直方向からのなす角θが30°である方向からの透過率の変化を全周測定した。

駆動条件

5V-STATIC波形を印加

実施例2

第3図は本発明第2の実施例における液晶シャッターの断面図である。同図に於て8は上偏光板9及び13はそれぞれ上下電極基板で、液晶層10に接する側の面はガラス表面をフッ酸等によりエッチングを施しその上にITOを形成、さらに配向処理を施してある。10の液晶層は90°のねじれ配向したネマチック液晶層でシール材11及びスペーサー12を介して挟持されている。14は下偏光板である。

尚上下電極基板9及び13のITO形成後の凹凸の大きさは共に高さが0~5μm、また凹凸の山と谷または谷と谷の間隔は10μm~500μmで不規則にならんでいる。

以上の様なセル構造でたとえば3μmのスペーサーを用いるとセル厚は同一セル内に3~13μの不規則なものができ、液晶の Δn を0.14とすれば、 $\Delta n \times d$ は0.42~1.82の範囲

で、同一セル内に不規則に有する事になる。よって本発明第1の実施例と同様に、広い視角範囲内で均一なコントラストを有する液晶シャッターを提供できる。

実施例3

第5図は本発明第1実施例における液晶シャッターをサングラスとして使用した一例である。メガネレンズとしての本発明の液晶シャッター17はボジ型にしてあり、太陽電池16の光起電力によりON-OFFする仕組みになっている。15はメガネフレームで、太陽電池の裏側に液晶シャッター駆動用の回路が内蔵してある。

なお、実施例1及び2において液晶層に90°ツイストしたネマチック液晶を用いた実施例について述べてきたが、本発明はこれに限定されるものではなく、ツイスト角、液晶材料は、電気光学素子として用いられるものなら何でも良い。また電極基板の凹凸の大きさも特に限定されるものではない。

(発明の効果)

以上述べたように、本発明の前記構成によれば広い視角範囲内において均一なコントラストを有する液晶シャッターを提供する事ができる。特にメガネとして使用する液晶サングラスや、3D装置(立体映像装置)に用いるメガネシャッター用として効果が大きい。

4. 図面の簡単な説明

第1図は本発明の液晶シャッターの断面図。

第2図は第1図の詳細図。

第3図は本発明第2の実施例における液晶シャッターの断面図。

第4図は本発明の液晶シャッターの視角方向と透過率の関係を表わす図(垂直方向からのなす角が30°のときの全周方向の透過率の変化)

第5図は本発明第1実施例における液晶シャッターをサングラスとして用いた正面図。

1・・・偏光板1

2・・・上電極基板

3・・・液晶層

4・・・シール材

5・・・スペーサー

6・・・下電極基板

7・・・下偏光板

h・・・下電極基板のITO上の凹凸の高低差

l・・・下電極基板のITO上の凹凸の山と山または谷と谷の間隔

d・・・セル厚

8・・・上偏光板

9・・・上電極基板

10・・・液晶層

11・・・シール材

12・・・スペーサー

13・・・下電極基板

14・・・下偏光板

A・・・本発明の液晶シャッターの視角-透過率特性

B・・・TN型液晶シャッターの視角-透過

率特性

15・・・メガネ用フレーム

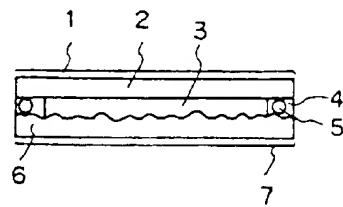
16・・・太陽電池

17・・・本発明の液晶シャッター

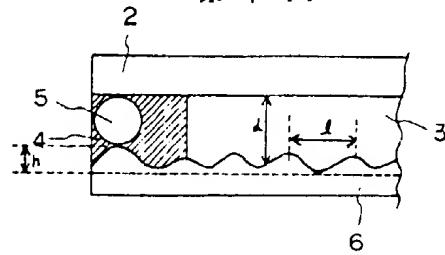
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出願人 セイコーエプソン株式会社

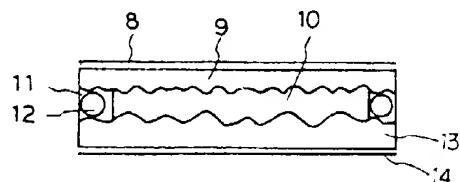
代理人 弁理士 鈴木 喜三郎(他1名)



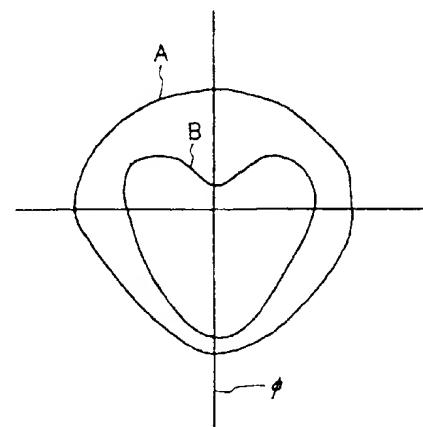
第1図



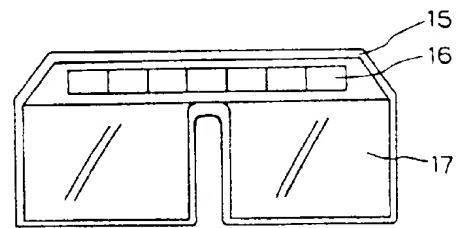
第2図



第3図



第4図



第5図

PTO 03-0803

CY=JP DATE=19900822 KIND=A
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LIQUID CRYSTAL SHUTTER
[Ekisho shatta]

Masahiro Kuroiwa

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. December 2002

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PRIORITY NUMBER (31) :

PRIORITY DATE (32) :

INVENTOR (72) : KUROIWA, MASAHIRO

APPLICANT (71) : Seiko Epson K.K.

TITLE (54) : LIQUID CRYSTAL SHUTTER

FOREIGN TITLE [54A] : Ekisho shatta

Specification

1. Name of this invention

Liquid Crystal Shutter

2. Claims

Liquid crystal shutter with the following characteristic:

With a liquid crystal shutter having a liquid crystal cell narrowly holding a liquid crystal layer oriented between a pair of electrode substrates having an electrode on each of the inner surface and a polarizing plate formed on the outside surface of at least one of said liquid crystal cell,

at least one of the surface contacting said liquid crystal layer of the electrode substrate is made into a surface with ruggedness.

3. Detailed Explanation of this Invention

[Industrial Field]

This invention pertains to a liquid crystal shutter.

[Conventional Technology]

With the conventional liquid crystal shutter, both side surfaces contacting the liquid crystal layer of a pair of electrode substrates tightly holding a liquid crystal layer are made as smooth surfaces.

[Problems to Be Solved by this Invention]

When the electrode surfaces of the electrode substrates are smooth as in the case of conventional device, a liquid crystal shutter requiring a uniform contrast has a limited vision angle, particularly at the time of voltage impression.

This invention was developed to solve this problem. The purpose of this invention is to provide a liquid crystal shutter having a wide vision angle range with a uniform contrast.

[Method to Solve the Problems]

To achieve the purpose as described above, this invention provides a liquid crystal shutter with the following characteristic:

With a liquid crystal shutter having a liquid crystal cell narrowly holding a liquid crystal layer oriented between a pair of electrode substrates having an electrode on each of the inner surface and a polarizing plate formed on the outside surface of at least one of said liquid crystal cell, at least one of the surface contacting said liquid crystal layer of the electrode substrate is made into an uneven surface.

[Operational Examples]

Figure 1 is a cross-sectional diagram showing the liquid crystal shutter based on this invention. In the figure, item **1** designates an upper polarization plate. Item **2** designates an upper electrode plate having a flat electrode surface subjected to an orientation process. Item **3** is a nematic liquid crystal layer

which is twisted at 90°, which is narrowly supported by the lower electrode substrate **6** facing against the electrode substrate **2** and sealing material **4**. The surface contacting the liquid crystal layer **3** of the lower electrode substrate **6** is prepared by etching the glass surface using fluoric acid, over which an ITO is formed and subjected to an orientation treatment. Item **5** is a spacer for maintaining a specific space between the upper and lower electrode substrates **2**, **6**, being mixed in the seal material **4**. Item **7** is a lower polarization plate. With the liquid shutter structured in this manner, the following explains the detailed configuration while referring to Fig. 2. In Fig. 2, the lower electrode substrate **6** is etched using fluoric acid, etc. to form ruggedness, onto which an ITO is formed using a spattering method, etc. The degree of ruggedness after the formation of ITO is 0 - 5 μm in its height (h), and the space (l) between the bottoms and tops of the ruggedness is 10 μm - 500 μm , being irregularly arranged.

The lower electrode substrate having the surface as described above and upper electrode surface **2** having a smooth electrode surface are made into a liquid crystal cell as shown in Fig. 1. In this case, if the spacer **5** is 5 μ , the cell thickness (d) of the liquid crystal cell consists of fully irregularly formed between 5 μ - 10 μ .

ON the other hand, the vision angle dependency of the liquid crystal cell occurs according to the multiplied value of refraction

ratio aerotropic characteristic Δn and cell thickness of the liquid crystal (i.e., forming a degree of $\Delta n \times d$; color changes) due to the newly formed vision angle. Assuming that the Δn of the crystal layer 3 in Fig. 2 is set as 0.08, $\Delta d \times d$ irregularly exists within a range of 0.4 - 0.8 μm in the same cell; when Δn is set as 0.16, $\Delta n \times d$ irregularly exists within a range of 0.8 - 1.6.

Therefore, the value of $\Delta n \cdot d$ changes at a fine pitch ($\ell = 10 - 500 \mu\text{m}$), the color produced by each $\Delta n \cdot d$ is reduced, thereby making the panel color almost invisible. Also, when the liquid crystal cell is observed from a oblique direction, since $\Delta n \cdot d$ changes at a dense pitch in the same manner, the chromaticity is not formed, subsequently allowing the production of liquid crystal shutter having a uniform contrast in a wide range of vision angles.

Figure 4 is a chart showing the relation between the vision angle direction and permeation ratio (at ON time) of a liquid crystal shutter structured as described in Operational example 1 and the conventional TN type liquid crystal shutter.

The conditions of the cells are described below. As shown in Fig. 4, the liquid crystal display device based on this invention can provide wider vision field range and more uniform contrast compared with the results obtained from the conventional TN type liquid crystal shutter.

Liquid crystal shutter based on this invention (A) :

- Positive type (the permeation ratio at the time of non-voltage

impression is displayed higher than the permeation ratio at
the time of impression time)

- $\Delta n \cdot d$ range = 0.8 - 1.6 μ
- Twist angle = 90°

TN type liquid crystal shutter (B) :

- Positive type
- $\Delta n \cdot d$ range = 1.1 μ
- Twist angle = 90°

Measurement condition:

The entire circumference of the permeation ratio changes was measured from the direction where the angle θ in the diagonal direction of the cell was 30°.

Drive condition:

5V-STATIC wave was impressed.

Operational example 2:

Figure 3 is a cross-sectional diagram of the liquid crystal shutter for Operational example 2. In the figure, items **8** designates an upper polarization plate. Items **9** and **13** respectively designate the upper and lower electrode substrates. The surface contacting the liquid crystal layer **10** is prepared by etching the glass surface using fluoric acid, etc., on which an ITO is formed and subjected to orientation. Item **10** is a liquid crystal layer is a nematic liquid crystal layer twisted for 90°, being narrowly supported by the seal material **11** and spacer **12**.

Item **14** is a lower polarization plate.

The degree of ruggedness after forming an ITO for the upper and lower electrode substrates **9** and **13** are both 0 - 5 μm , and the space between the top and bottom of ruggedness is irregularly arranged within a range of 10 μm - 500 μm .

When a 3 μm spacer is used with the cell structure as described above, irregular cell thickness (3 - 13 μ) is formed in the same cell. When Δn is 0.14, $\Delta n \times d$ irregularly exists within a range of 0.42 - 1.82 in the same cell. Therefore, as described in Operational example 1, a liquid crystal shutter having a wide range of vision angle with a uniform contrast can be proved.

Operational example 3:

Figure 5 is a diagram showing an example when the liquid crystal shutter prepared in Operational example 1 is used as a sun glass. The liquid crystal shutter **17** based on this invention used as a glass lens is made into positive type and designed to be set ON-OFF by the photoelectric motive force by a solar battery **16**. Item **15** is a glass frame containing an internally built circuit on the back side of the solar battery for liquid crystal operation.

Note that, although the examples used a nematic liquid crystal twisted for 90°, this invention is not limited to those examples, as any twisting angle and liquid crystal material can be used as long as applicable to the photoelectric motive elements. Also, the ruggedness of the electrode substrate is not particularly limited

in this invention.

[Effectiveness of this Invention]

As described above, with the configuration of this invention, a liquid crystal shutter having a uniform contrast within a wide range of vision angle can be provided. Particularly, the method based on this invention is effective for glass shutters used as a liquid crystal sunglass and 3D device (3-D image device).

4. Simple Explanation of the Figures

Figure 1 is a cross-sectional diagram showing the liquid crystal shutter based on this invention. Figure 2 is a diagram showing more detailed structure of the device shown in Fig. 1. Figure 3 is a cross-sectional diagram of a liquid crystal shutter used in Operational example 2 of this invention. Figure 4 is a chart showing the relation between the vision angle direction and permeation ratio (permeation ratio changes in the circumference direction when the angle in the diagonal direction is 30°). Figure 5 is a diagram showing an example when the liquid crystal shutter prepared in Operational example 1 is used as a sun glass.

1...Polarization plate 1;	7...Lower polarization plate;
2...Upper electrode substrate;	h...Gap between the top and bottom of ruggedness on the ITO of a lower electrode substrate;
3...Liquid crystal layer;	{...Space between the top and bottom of ruggedness on the ITO of a lower electrode substrate;
4...Seal material;	d...Cell thickness;
5...Spacer;	
6...Lower electrode substrate;	8...Upper polarization plate;

9....Upper electrode substrate;
10....Liquid crystal layer;
11....Seal material;
12....Spacer;
13....Lower electrode substrate;
14....Lower polarization plate;

A....Vision angle-permeation
ratio characteristic of the
liquid crystal shutter of this
invention;

B....Vision angle-permeation
ratio characteristic of TN type
liquid crystal shutter;

15....Glass frame;
16....Solar battery;

17....Liquid crystal shutter of
this invention

